

REMARKS

Claims 1, 3-8 and 10-17 are pending. Favorable reconsideration is respectfully requested.

The rejection of the claims under 35 U.S.C. §102(e) over Takase et al. (U.S. publication No. 2005/0253221) is respectfully traversed. Takase et al. is not available as prior art against the present application.

Takase et al. was published on November 17, 2005 and was filed on April 16, 2003.

The present application is a National Stage of a PCT application filed on June 30, 2003. The present application claims priority to Japanese application No. 2002-208515, which was filed on July 17, 2002. A copy of the certified English translation of the Japanese priority application is submitted herewith. Applicants submit that the claims of the present application are described by the priority application. Accordingly, since July 17, 2002 is prior to June 30, 2003, Takase et al. is not available as prior art against the present application. Accordingly, withdrawal of this ground of rejection is respectfully requested.

The rejections of the claims under 35 U.S.C. §103(a) over Abe et al. (EP 1 087 041 A1) in view of Babich et al. or over Abe et al. in view of Babich et al. and further in view of Kodate et al. are respectfully traversed. The cited references fail to suggest the claimed high-resistance silicon wafer and the method of making the same.

When producing a high-resistance wafer with a specific resistivity of 100 Ωcm or more, if the concentration of the remaining oxygen in the wafer is lowered, a thermal donor (TD) can be prevented from being generated, and variation in resistivity can be restricted. However, as described in the specification, lowering the remaining oxygen concentration in the wafer causes a problem of lowering the strength of the wafer, which generates a slip dislocation. Meanwhile, when a heat treatment which would form an oxygen precipitate (BMD) in the wafer at a high density is performed, so as to lower the remaining oxygen

concentration in the wafer, the formed oxygen precipitate itself becomes a source of the slip dislocation, and thereby causes a slip dislocation.

Accordingly, the relationship between the generation of the slip dislocation caused by the remaining oxygen concentration in the wafer and the generation of TD is contradictory. In this regard, the remaining oxygen concentration in the wafer is significant meaning in terms of wafer property.

The present invention seeks to prevent the thermal donor (TD) from being generated by doping carbon so as to restrict the variation in resistivity because of the formation of the thermal donor (TD), which is a problem in high-resistance silicon wafers. More specifically, the inventions restrict the generation of TD, without depending on the remaining oxygen concentration, to maintain the remaining oxygen concentration at a high level, so as to, at the same time, improve the mechanical strength of the wafer and lower the heat treatment cost.

In particular, in the wafer of the present invention, the carbon concentration is 5×10^{15} to 5×10^{17} atoms/cm³, and the remaining oxygen concentration is over 8×10^{17} atoms/cm³ (Old-ASTM) in Claims 1, 14 and 16; 6.5×10^{17} atoms/cm³ or more (Old-ASTM) in Claim 8.

In Abe et al., the remaining oxygen concentration is lowered to an oxygen concentration where TD would not be generated. More specifically, the invention described in that reference prevents TD from being generated by subjecting the wafer to a heat treatment which forms BMD in the wafer, so as to lower the remaining oxygen concentration in the wafer to an oxygen concentration range of 8 ppma (JAIDA) = 6.4×10^{17} atoms/cm³ (Old-ASTM) or less, wherein TD would not be generated. As mentioned above, in such a low remaining oxygen concentration, a slip dislocation would be generated.

In the present invention, TD is prevented from being generated by carbon doping, which is not considered by Abe et al. Therefore, the remaining oxygen concentration can be maintained at a high level. The level of the remaining oxygen concentration is higher than

that of Abe et al. As a result of these facts, the claimed invention aims to prevent both TD and slip dislocation at the same time, which cannot be achieved by Abe et al. In that reference, TD can be prevented as the remaining oxygen concentration is low, but slip dislocation cannot be prevented.

Babich et al. describes the difference between the amounts of TD generation in a case where the wafer is doped with carbon at a high concentration, and that in a case where the concentration of carbon is decreased to a low level.

Specifically, Babich et al. provides a comparative experiment between:

Crystl 1: where a wafer having a high oxygen concentration (9.6×10^{17} atoms/cm³) is doped with carbon at a low concentration (3×10^{16} atoms/cm³), and

Crystl 2: where a wafer having a low oxygen concentration (7×10^{17} atoms/cm³) is doped with carbon at a low concentration (8×10^{17} atoms/cm³).

Further, Babich et al. reports that; in Crystl 2, where a wafer having a low oxygen concentration is doped with carbon at a high concentration, TD is generated in a small amount even if the wafer is subjected to a heat treatment at a temperature of 400 to 500°C, and; in Crystl 1, where a wafer having a high oxygen concentration is doped with carbon at a low concentration, TD is generated in a large amount.

In Crystl 2, where TD is generated in a small amount, the oxygen concentration is 7×10^{17} atoms/cm³, and the carbon concentration is 8×10^{17} atoms/cm³. The carbon concentration is undoubtedly higher, and to the contrary, the oxygen concentration tends to be lower, compared to the inventions of the subject application teaching the remaining oxygen concentration of 6.5×10^{17} atoms/cm³ or more, over 8×10^{17} atoms/cm³.

Thus, the article by Babich et al. indicates the effectiveness of doping at a low oxygen concentration and doping at a high carbon concentration, in restricting TD.

This is contrary to the claimed invention, which aims to prevent both TD and slip dislocation by means of doping at a high oxygen concentration, and doping at a low carbon concentration. Babich et al. does not suggest or disclose the adoption or effectiveness of the carbon concentration (5×10^{15} to 5×10^{17} atoms/cm³) provided by the present invention.

In addition, the article by Babich et al. is neither a report on high-resistance wafer, nor a disclosure of a high-resistance wafer having a high oxygen concentration in terms of a remaining oxygen concentration of over 8×10^{17} atoms/cm³.

Even if Babich et al. is considered in combination with Abe et al., the combination only shows the effectiveness of the carbon doping at a high concentration of 8×10^{17} atoms/cm³ to a wafer having a low oxygen concentration in terms of a remaining oxygen concentration of 6.4×10^{17} atoms/cm³ or less. Accordingly, such a combination, if any, does not teach or suggest the feature of the invention of the present application wherein carbon at a low concentration is doped to a wafer having a high oxygen concentration.

Further, as the invention by Abe et al. lowers the oxygen concentration to a range where TD would not be generated. Accordingly, there is no necessity of doping carbon to restrict TD, nor a reason to combine the two references.

The article of Kodate et al. which fails to specify the composition (oxygen concentration, carbon concentration) of the high-resistance wafer used, does not teach the construction of the present invention. The article merely reports that a high-resistance SIMOX wafer suppress crosstalk.

In view of the foregoing, the claims are not obvious over Abe et al. in view of Babich et al. or over Abe et al. in view of Babich et al. and further in view of Kodate et al. Accordingly, withdrawal of these grounds of rejection is respectfully requested.

Application No. 10/519,837
Reply to Office Action of December 13, 2006

Applicants respectfully request that the obviousness-type double patenting rejection of Claims 1-5 of the present application over Claims 1-5 of co-pending application serial No. 10/512,405 be held in abeyance until an indication of allowable subject matter. If necessary, a Terminal Disclaimer will be filed at that time.

Applicants submit that the present application is in condition for allowance. Early notice to this effect is earnestly solicited.

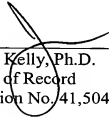
Respectfully submitted,

OBLON, SPIVAK, McCLELLAND,
MAIER & NEUSTADT, P.C.
Norman F. Oblon

Customer Number

22850

Tel: (703) 413-3000
Fax: (703) 413 -2220
(OSMMN 06/04)



James J. Kelly, Ph.D.
Attorney of Record
Registration No. 41,504